دراسة صوتية لتركيبة الصوامت في اللغة الإنكليزية

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الملخص

تختلف اللغات حول العالم، كما ورد في دراسات سابقة، على تقسيم المقاطع الصوتية. فهناك لغات تسمح بالترتيب (ساكن– صوتي) بينما تسمح لغات أخرى بتنسيق آخر يتضمن أول المقطع وآخره. لقد تم تنظيم هذه المقاطع بتسلسل معين وفقاً لمبادئ متبعة عالمياً. ويتم التحكم بتنظيم هذه المقاطع الصوتية وفقاً لنظرية التسلسل الصوتي والتسلسل الهرمي المتبع في هذه النظرية الذي يرتب المقطع الصوتي من الأكثر قيمة تسلسلية إلى الأقل. وتكشف هذه الدراسة عن المدارك الحسية لمقياس قوة السمع من وجهة نظر نظرية التسلسل الصوتي. ويُستخدم مخطط الطيف الخاص بالأصوات للمساعدة على تسليط الضوء على أهمية الرابط بين هذه النظرية والصوت بحد ذاته في اللغة الإنكليزية. من وجهة نظر صوتية، فإن الكثافة أو الشدة والموجات والرسوم البيانية الخاصة بالموجات تدعم هذه النظرية بشكل تام.

الكلمات المفتاحية: مقاطع صوتية، التسلسل الهرمي، نظرية التسلسل الصوتي، الكثافة.

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An Acoustic Study of Consonant Combination in Standard English

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Abstract

As discussed before by many linguists, languages of the world differ in their syllable phonotactics. Some languages only allow CV sequences; others allow more complex structures both in the margins and nuclei. Across languages, segments are organized into well-formed sequences according to universal principles of segment sequencing. The organization of segments within the syllable, is assumed to be driven by the sonority principle, which is a property that works on ranking segments along a hierarchy from most sonorous to least sonorous. This study explores the perceptibility of English sonority profiling from the perspective of the Sonority Sequencing Principle (SSP). Sample spectrograms are also provided to help highlight the significance of the acoustic correlates in signifying the relative English sonority. Acoustically speaking, measuring the intensity and waveform charts support the SSP and sonority scaling.

Keywords: syllable phonotactics, hierarchy, Sonority Sequencing Principle (SSP), intensity.

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1- Introduction

Phonotactics studies the way a language structures its syllables and their distributional properties of phonemes. In this regard, [1] views phonotactics as "A term used in phonology to refer to the sequential arrangements of phonological units which occur in a language-what counts as phonologically well- formed word".

1-1 The syllable

The "syllable" is a basic unit of speech which has been extensively studied on both phonetic and phonological levels of analysis. Phonetically, syllables are usually described as "consisting of a centre which has little or no obstruction to airflow and which sounds comparatively loud and before and after this centre (margins of the syllable), there will be greater obstruction to airflow and/or less loud sound"[2]. As stated by [3] the syllable is "a unit of phonological organization, typically larger than a segment and smaller than a word" (p.314). Every syllable has a nucleus, consisting of a vowel or syllabic consonant. On his side [4] defines the phonological syllable as "a complex unit made up of nucleus and marginal elements". Nucleus elements are the vowels or syllabic consonants; marginal elements are the consonants or non-syllabic segments.

In the syllable *paint*, /peɪnt/, the diphthong /eɪ/ is the nucleus element, while the initial consonants /p/ and the final cluster /nt/ are the marginal elements. According to [5] ,"the syllable is at the heart of the phonological representation. It is the unit in terms of which phonological systems are organized".

The common patterns of syllable structure in all languages comprise four sequences: CV, V, CVC, VC. Specifically, there is a consensus among most linguistic researchers that the CV syllable is an absolute universal syllable pattern across all world languages. Thus, some phoneticians call this pattern the core syllable structure in all languages. It is common in most languages to have two or more Cs in

[1] CRYSTAL, D. 2003. **A Dictionary of Linguistics and Phonetics**. (5th ed.). Malden: Blackwell Publishing. p.352

[2] ROACH, P. 2000. **English phonetics and phonology**: **A practical course** Cambridge University Press: Cambridge. p. 67

[3] ROGERS, H. 2004**. A linguistic Approach**. International Journal of American Linguistics. P.39

[4] LAVER, J. 1994. **Principles of Phonetics**. Cambridge: CUP.

[5] KATAMBA, F. 1993. **Morphology. Modern Linguistics Series**. University of Essex.p. 153

one syllable with no vowel in between, which is called a cluster [1]. Languages of the world differ in their syllable phonotactics. As stated by[2] Phonotactic constraint refers to limitations on the distribution of sounds and sound sequences at various points (initial, medial, final) in the phonological word or phrase).

1-2 The phonotactic constraints in English

As stated by [3], the following facts on the distribution of consonant phonemes in English are :

1- /ŋ/ does not occur initially, it always occupies the final position after lax vowels, i.e., only after / ɪ, a, e, ʌ, ɒ / as in, *ring* /rɪŋ/.

2- /3/occurs finally in words of French origin after /i: a: u: eɪ / and initially only before /ɪ/ and /i:/ in some foreign words, such as, *gigolo, gigue, zhivago.*

3- In the initial position: a cluster of three elements is allowed as a maximum number.

4. The second consonant in a complex coda must not be /r/, /ŋ/, /ʒ/, or /ð/ (compare *asthma*, typically pronounced /ˈæzmə/ or /ˈæsmə/, but rarely /ˈæzðmə/)

5. / r, h, j, w / do not occur finally.

6. /ð/ occurs only after / ɪ, i: u: eɪ, aɪ, əʊ, aʊ /.

7. /g/ occurs only after / ɪ, e, a, ɒ, i: ə: a: ɔ: u: eɪ, əʊ/.

8. Only /d/ occurs after all vowels.

9. In final position a cluster of four elements is allowed as a maximum number in English.

10. In general, clusters are not possible with / ð/, /d3/, or /z/.

1-3 Sonority

Phonologically, Sonority is how segments arrange into syllables, its dependence upon the degree of opening of the vocal tract during articulation , in other words , the more open the vocal tract, the higher the sonority, and a sound's tendency for voicing (i.e., voiced sounds are more sonorous than their voiceless counterparts, even when the degree of opening of the vocal tract remains the same for both voiced and unvoiced sound; consequently, the narrower the opening of the vocal tract, the lower the sonority of a sound). Figure 1 illustrates

[1] LASS, R. 1984. Phonology**: An Introduction to Basic Concepts**. Cambridge: CUP. p. 250

[2] KENSTOWICZ, Michael J**. Phonology in Generative Grammar**, Cambridge: Blackwell. 1994.

[3] CRYSTAL, D. 2003. **A Dictionary of Linguistics and Phonetics. (5th ed.).** Malden: Blackwell Publishing

the sonority hierarchy for the relevant phonemes considered in this study, beginning with the least sonorous /t/ and ending with the most sonorous /l/:

/t/ → /s/ → /n/ → /l/

According to the SSP[1], syllables have a preferred shape. They rise maximally in sonority toward the nucleus (i.e., the vowel) and lower in sonority levels toward the coda. Based on behavioural evidence and findings from laboratory studies,[2] has shown that syllables are not simply linear strings of phonemes, but hierarchically organized internally using two major constituents, the onset and the rime. While the onset is made up of an initial consonant or consonant cluster, the rime is made up of a nucleus, usually a vowel, and may also contain a consonant in the coda position. English allows for branching onsets and codas, known as consonant clusters.

According to sonority theory, the pulses of pulmonic air stream in speech "correspond to peak in sonority"[3]. The sonority of speech sound is " its relative loudness compared to other sounds". Put it technically, sonority is " the overall loudness of a sound relative to others of the same pitch, stress and duration"[4].

This theory proposes that each syllable corresponds to a peak in the flow rate of pulmonic air. Thus nuclear elements, or syllabic segments can be described as intrinsically more sonorous than marginal, non-syllabic elements. Speech sounds can be ranked in terms of sonority according to a sonority profile[5]. Sonority is typically taken to be a universal scalar feature ordering the various types of segments with respect to loudness or intensity[6]. Sonority Sequencing Principle (SSP) is one version of this theory, which stipulates that onsets rise in

[1] CLEMENTS, G.N. 1990. " **The Role of the Sonority Cycle in Core Syllabification"**. In Papers in Laboratory Phonology: between Grammar and Physics of Speech", edited by John Kingston and Mary Beckman, pp. 283-333. Cambridge: CUP.

[2] TREIMAN. R 1985. **Spelling of stop consonants after /s/ by children and Adults.** Applied Psycholinguistics, p. 261-282

[3] GIEGERICH, H.J. 1992. **English Phonology**. Cambridge: CUP p.132

[4] CRYSTAL, D. 2003. **A Dictionary of Linguistics and Phonetics**. (5th ed.). Malden: Blackwell Publishing. p.423

[5] HAUSER, I. 2013. **" Sonority as a Primitive: Evidence from Phonological Inventories**". West Coast Conference on Formal Linguistics, Arizona State University. February, 8, 2013.

[6] PARKER, St. 2002. **Qualifying the Sonority Hierarchy**. Ph.D. Dissertation. University of Massachusetts. Amherst.

sonority toward the nucleus, while codas fall in sonority. From this, we can predict which consonant clustering is more licensed for onsets and codas[1].

On the other hand, [2]states that the lexicon has a set of phonotactic constraints which function as a filter allowing entry only to phonologically well-formed words. Before any putative word can enter the lexicon, it must have a combination of sounds that is permissible in the language. Phonologically speaking, phonotactics is defined as "the statements of permitted string of phonemes including clusters, sequences, distributional restrictions and admissible syllable patterns" [3]

1-4 Sonority Scale (hierarchy)

According to[4] , spoken syllables are best characterized as hierarichally organized units not as linear strings of phonemes. These units consist of an onset (initial consonant or consonant cluster) and a peak or nucleus (the vowel) and a coda (the final consonants). In general, voiced segments are more sonorous than voiceless ones and sonorants are more sonorous than obstruents.

Vowels are more sonorous than consonants and the low vowels are more sonorous than the high ones. The sonority scale of English sounds has many implications in consonant clusters[5].

The sequence of consonants in a syllable is restricted by the possible phonotactic constraints and phonological rules of a language. The sonority of the segments is one of the factors that constraint the tautosyllabic clusters (clusters within the same syllable). The nucleus is the sonority peak of a syllable within the internal structure of a syllable. It is expected that the value of sonority decreases the farther segment is from the nucleus and increases when it gets closer to the nucleus.

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[1] HARRINGTON, J. AND COX, F. 2009. **The Syllable and Phonotactic Constraints. Macquarie**: Macquarie University Press.

[2] KATAMBA, F. 1993. **Morphology. Modern Linguistics Series**. University of Essex

[3] Lass, R. 1984. **Phonology: An Introduction to Basic Concepts**. Cambridge: CUP. (p.23).

[4] TREIMAN, R 1983. **The Structure of Spoken Syllables**: Evidence from novel word games. Cognition,15,49- 74.

[5] ROGERS, H. 2004**. A linguistic Approach.** International Journal of American Linguistics.

This is phonologically referred to as the Universal Sonority Sequencing Principle (SSP), which entails that onsets rise in sonority and codas fall in sonority[1]. As stated by[2], this ranking was put based on the sonority scale O< N< L< G< V (where, O stands for Obstruent that includes Stops and Fricatives, N for Nasal, L for Liquid, G for Glide, and V for Vowel). This sonority scale implies the unmarked order of segment types within an initial demi syllable known as ONLGV.

2- Statement of the Problem

Every language has its own distribution of phonemes within the framework of syllables. The distribution of consonants in Standard English is either in the onset position or in the coda position or both. This study tries to shed light on the following points: 1) consonant phonotactics and the phonotactic constraints in Standard English, 2) the most acoustic reliable correlate of the sonority sequencing principle.

3- Research Questions

This study aims at addressing the following questions:

1. What is the acoustic correlate of sonority of consonant combination?
2. Do phonotactic rules affect the consonant combination in English?

4- Methodology

This study will investigate the phonotactic rules of consonant cluster or constraints in English in terms of phonology; in other words, how these rules behave phonologically. The intensity of a sound wave is measured in decibels (dB) and represents the power and loudness of the wave. Intensity is correlated with the amplitude of the wave, or how high above (compression) or below (rarefaction) the baseline the wave reaches in each cycle. Intensity in The Oxford Dictionary of English Grammar is defined as the amount of energy used in the production of a speech sound.

4-1 Procedure :After discussing the consonant combination in Standard English, several words will be measured depending on

[1] CLEMENTS, G.N. 1990. " **The Role of the Sonority Cycle in Core Syllabification**". In Papers in Laboratory Phonology: between Grammar and Physics of Speech", edited by John Kingston and Mary Beckman, pp. 283-333. Cambridge: CUP

[2] CLEMENTS, G.N. 1990. " **The Role of the Sonority Cycle in Core Syllabification**". (Ibid)

intensity using PRAAT. Thus, the typical work flow is to collect data, transcribe, extract measurements via PRAAT[1]. The acoustic correlates of the sonority , which is intensity, of consonant combination in English will be examined , since it is the most reliable acoustic predictor of sonority.[2]

4-2 Measurements and results :'The sonority of a sound is its loudness relative to that of other sounds with the same length, stress and pitch"[3]. As mentioned before, the SSP requires onsets to rise in sonority towards the nucleus and codas to fall from the nucleus[4]. According to the sonority hierarchy, in onsets, the consonant at the first position must be less sonorous than the other one in the second position. The more we move toward the vowel, the higher the sonority value will be. The Sonority Sequencing Principle requires that syllable onsets increase in sonority and codas decrease in sonority, and the sonority peak supposed to be in the syllable nucleus.

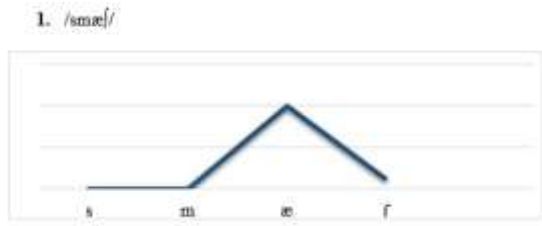

Figure (1) sonority hierarchy of the token smash

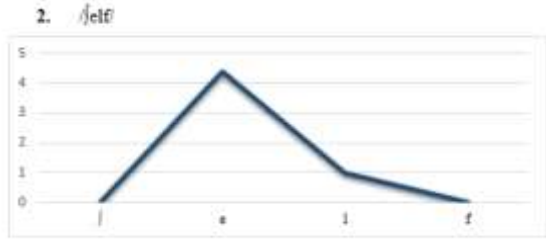

Figure (2) sonority hierarchy of the token shelf

[1] BOERSMA & WEENINK,2021, version 6.1.38

[2] PARKER, ST. 2002. **Qualifying the Sonority Hierarchy**. Ph.D. Dissertation. University of Massachusetts. Amherst

[3] LADEFOGED, P. 1993. **A Course in Phonetics.** (3rd.ed.). New York: Harcourt Brace College

[4] KENSTOWICZ, M. 1994. **Sonority-Driven Stress**. Ms., MIT.

A great emphasis will be given to intensity since it is the most reliable acoustic predictor of sonority[1]. The intensity of a sound wave is measured in decibels (dB) and represents the power and loudness of the wave. Intensity is correlated with the amplitude of the wave, or how high above (compression) or below (rarefaction) the baseline the wave reaches in each cycle. In this case, amplitude is an objective measurement of loudness, which is a more subjective measure of sound.

* Waveforms and intensity records included in this section are the output of the analysis of the speech of the same talker of whom the tokens were recorded, Oxford Dictionary Online. The software deployed for acoustic measurements is PRAAT (Version 9. 0).

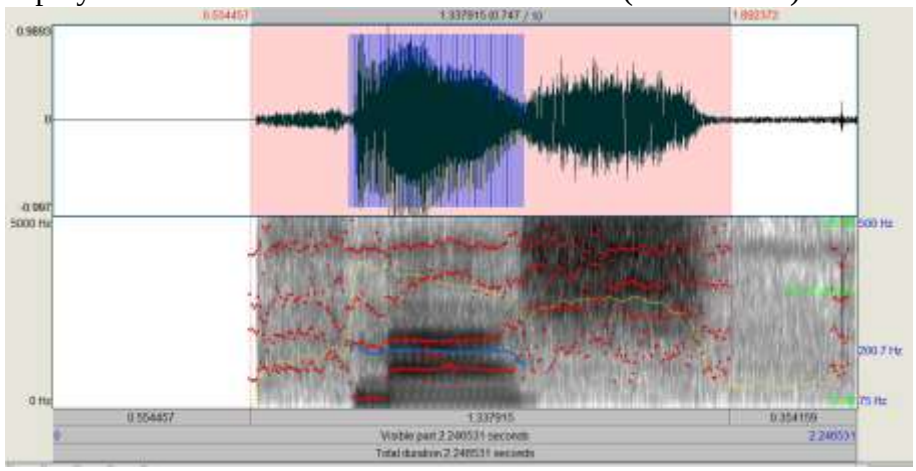

Figure (4) Waveform of smash /smæʃ/

[1] PARKER, ST. 2002. **Qualifying the Sonority Hierarchy.** Ph.D. Dissertation. University of Massachusetts. Amherst.

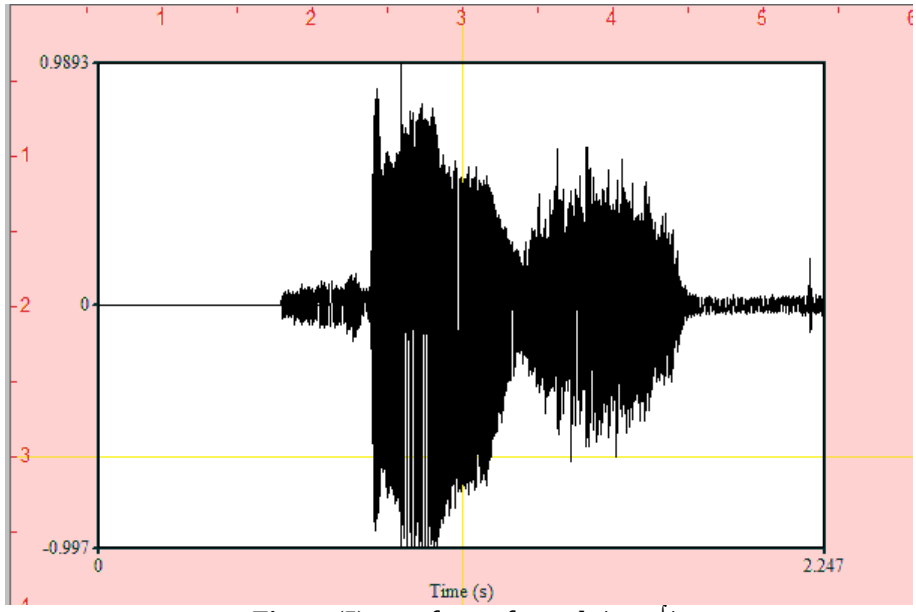

Figure (5) waveform of smash /smæʃ/

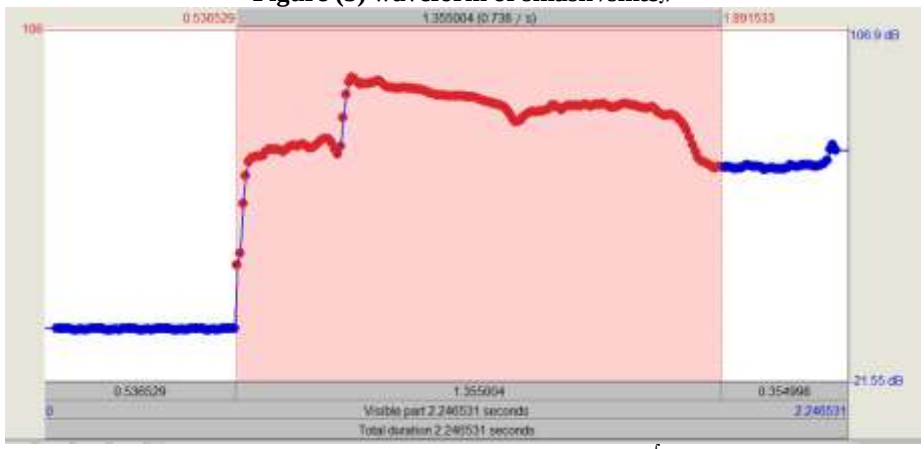

Figure (6) Intensity of smash /smæʃ/

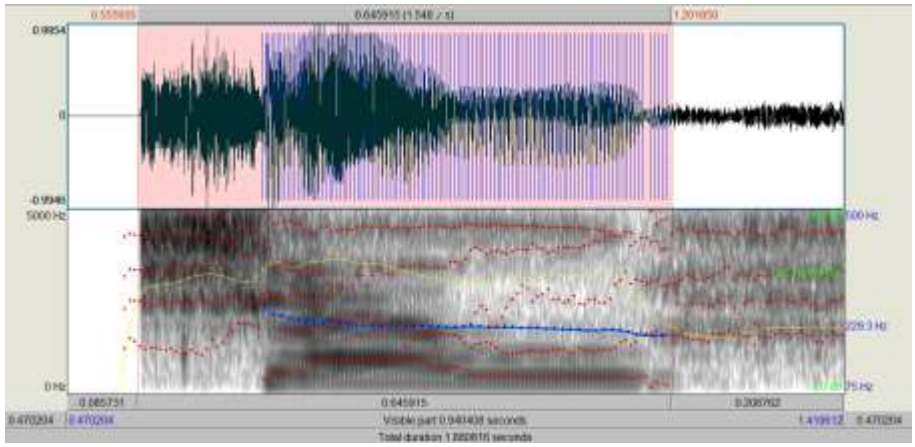

Figure (7) Waveform of shelf / ʃelf/

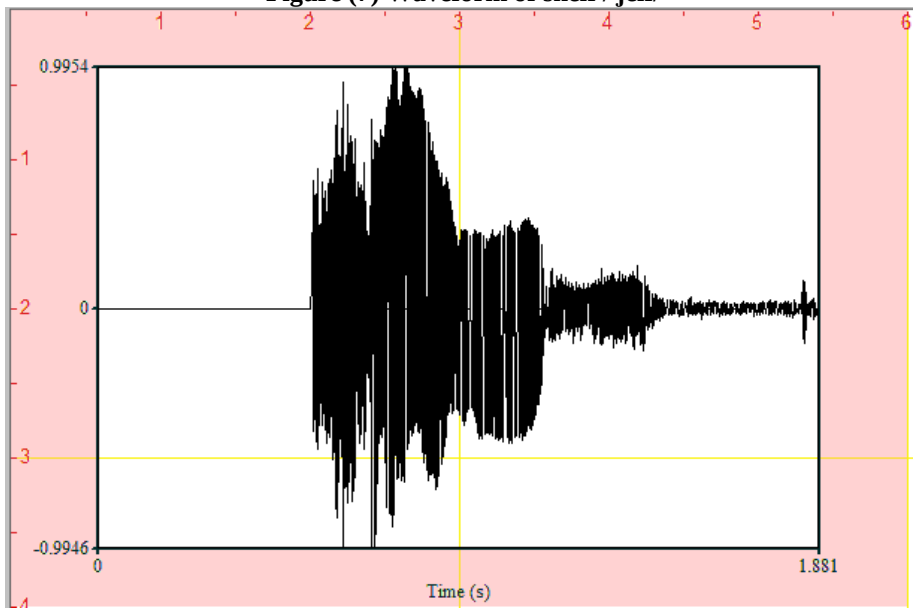

Figure (8) waveform of shelf /ʃelf/

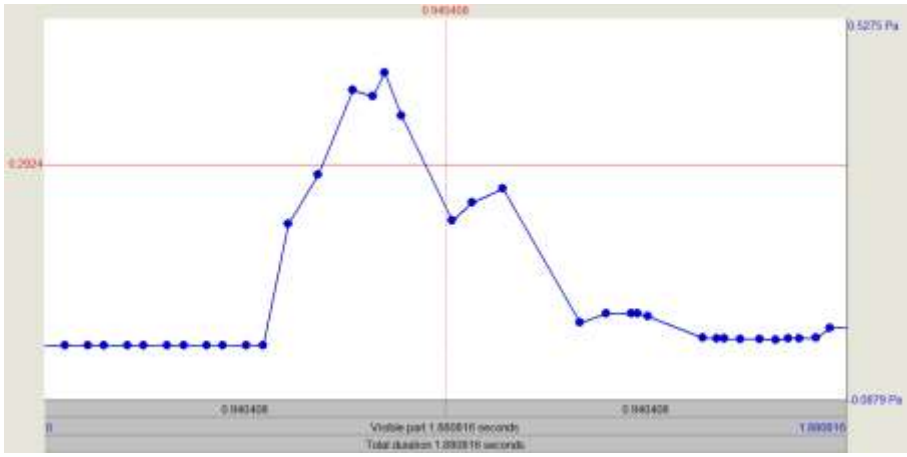

Figure (9) Intensity of shelf / ʃelf /

5- Discussion

As stated by [1], " acoustic intensity is the appropriate measure corresponding to loudness". This intensity is proportional to the amplitude of the variations in air pressure. According to the intensity scale, vowels have the highest intensity. The lateral and nasals have slightly less intensity than vowels, voiced fricatives have very little intensity. Voiceless plosives show no intensity during closure[2].

Figure (6) is a record of the intensity of the segments of the token /smæʃ/. It starts with (0.997) dB. (decibels) with the voiceless fricative obstruent /s/, then in the peak which is the vowel /æ/ it rises to be (0.9893) dB. Then it changes in the voiceless fricative coda /ʃ/ to be (2.247) dB. So, we can say that this example abides by the sonority hierarchy and the SSP because the onset increases in sonority and codas decreases, and the sonority peak is in the syllable nucleus.

6- conclusion

Sonority is a scalar phonological feature which classifies all speech sounds into an autonomous hierarchy[3]. The best correlate of sonority is intensity. Intensity (loudness) increases gradually on the onset, reaching it maximum value on the peak. Then, it drops down on the coda. Loudness increases as we move downward to the open position, and gradually decreases as we move upward to the close

[1] LADEFOGED, P. 1993. **A Course in Phonetics**. (3rd.ed.). New York: Harcourt Brace College

[2] PARKER, St. 2002. **Qualifying the Sonority Hierarchy.** Ph.D. Dissertation. University of Massachusetts. Amherst.

[3] ibid

position. By applying this to the previous tokens, we can find that they follow the sonority sequencing principle with its best acoustic correlate which is intensity.

References

1. AL-TAMIMI, Y.A.S. AND AL-SHBOUL, Y. 2012. **" Is thePhonotactics of the Arabic Complex Coda Sonority-Based".** In Journal of King Saud University- Language and Translation 01/2013, Vol.25, Issue (1), pp. 34-57.
2. BERKLEY, D. 1994b. **Studies in the Linguistic Sciences** 24.59–72.
3. BOERSMA & WEENINK,2021, version 6.1.38
4. CLEMENTS, G.N. 1990. **" The Role of the Sonority Cycle inCore Syllabification"**. In Papers in Laboratory Phonology: between Grammar and Physics of Speech", edited by John Kingston and Mary Beckman, pp. 283-333. Cambridge: CUP.
5. CRYSTAL, D. 2003. **A Dictionary of Linguistics and Phonetics.** (5^{th} ed.). Malden: Blackwell Publishing.
6. GEIRUT, J. 1999. " **Syllable Onsets: Clusters and Adjuncts in Acquisition".** Journal of Speech, Language and Hearing Research. Vol. 44, 886-904.
7. GIEGERICH, H.J. 1992**. English Phonology**. Cambridge: CUP.
8. HARRINGTON, J. AND COX, F. 2009.**The Syllable andPhonotactic Constraints. Macquarie:** Macquarie University Press.
9. HAUSER, I. 2013. " **Sonority as a Primitive: Evidence fromPhonological Inventories**". West Coast Conference on Formal Linguistics, Arizona State University. February, 8, 2013.
10. KATAMBA, F. 1993. **Morphology. Modern Linguistics Series**. University of Essex.
11. KENSTOWICZ, M. 1994**. Sonority-Driven Stress**. Ms., MIT.
12. KIRCHNER, R. (Eds.)., **Phonetically Based Phonology**, pp.34-57. Cambridge: CUP
13. LADEFOGED, P. 1993. **A Course in Phonetics**. (3rd.ed.). New York: Harcourt Brace College Publishers.
14. LASS, R. 1984. **Phonology: An Introduction to Basic Concepts. Cambridge**: CUP.

15. LAVER, J. 1994. **Principles of Phonetics**. Cambridge: CUP.
16. MCCARTHY, J. 2010. **Auto segmental Spreading in Optimality Theory**. In John Goldsmith, Elizabeth Hume, &Leo Wetzels, (eds.), *Tones and Features*, 195–222. Berlin and New York: Mouton de Gruyter.
17. MCMAHON, A. 2002. **An Introduction to English Phonology**. Edinburgh: Edinburgh University Press.
18. NATHAN, G.S. 2014**. Phonology: A Cognitive GrammarIntroduction**. Amsterdam/Philadelphia: John Benjamin's Publishing.
19. PARKER, St. 2002. **Qualifying the Sonority Hierarchy.** Ph.D. Dissertation. University of Massachusetts. Amherst.
20. RADFORD, A.; ATKINSON, M.; BRITAIN, D.; CLASHEN, H. AND SPENCER, A.1999. **Linguistics: An Introduction**. Cambridge: CUP.
21. ROACH, P. 2000. **English phonetics and phonology**: A Practical Course. Cambridge University Press: Cambridge.
22. ROACH, P. 2009. **English Phonetics and Phonology**: A Practical Course. (4th.ed.). Cambridge: CUP.
23. ROGERS, H. 2004**. A linguistic Approach**. International Journal of American Linguistics.
24. TREIMAN, R 1985. **Spelling of Stop Consonants after /s/ by children and Adults**. Applied Psycholinguistics, p. 261-282.
25. TREIMAN, R 1983. **The Structure of Spoken Syllables**: Evidence from novel word games. Cognition,15,49- 74.
26. YAVAS, M. 2013. **Applied English Phonology. (**2nd.ed.). Malden: Wiley-Blackwell.
27. YULE, G. 2002. **The Study of Language**. Cambridge: Cambridge University Press.